Exhibit 8

Knox & Associates, LLC

Firearms, Ballistics & Shooting Incident Reconstruction *We Bring Truth to Light*

Forensic Analysis & Reconstruction Report

Case: Sabein Burgess v. Baltimore Police Department, et al.
United States District Court for the District of Maryland
Case No. 1:15-cv-00834-RDB

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Date of Report: July 28, 2017

K&A Case No.: 16-0068

1. Purpose and Scope

1.1. The purpose of this report is to present findings with regard to the analysis of gunshot residue in this case.

1.2. The scope of this report covers gunshot residue collection, analysis, reporting, and associated testimony.

2. Abbreviations Used in this Report

2.1. **BPD**: Baltimore Police Department

2.2. **GSR**: Gunshot residue (also known as firearms discharge residue)

2.3. **SEM**: Scanning electron microscope

2.4. **SWGGSR**: Scientific Working Group for Gunshot Residue

3. Qualifications & Expertise

3.1. Relevant Expertise

3.1.1. Crime Scene Investigation, Analysis & Reconstruction

3.1.2. Firearms, Ballistics & Shooting Incidents

3.1.3. Gunshot Wound Dynamics

3.1.4. Gunshot Residue

3.1.5. Bloodstain Pattern Analysis

3.1.6. Equivocal Death Analysis

3.2. Education

3.2.1. Ph.D. Candidate, Criminal Justice (Nova Southeastern University)

3.2.1.1. Concentration in Behavioral Science

3.2.1.2. Emphasis on Statistical Methods, Data Analysis, Quantitative & Qualitative Research Methodology, Program Evaluation

3.2.1.3. Dissertation topic (underway): *Crime scene behaviors of rampage school shooters: Developing strategies for planning for, responding to, and investigating active shooter incidents at schools*

3.2.2. M.S., Forensic Science (University of Florida)

3.2.2.1. General Forensic Science Track

3.2.2.2. Coursework included:

- Principles of Forensic Science
- Forensic Medicine
- Forensic Anthropology
- Forensic Entomology
- Blood Distribution & Spatter
- Blood Evidence & Serology
- Forensic Toxicology
- Scientific Evidence & Statistics
- Laboratory QA/QC

3.2.3. B.S., Mechanical Engineering (University of North Florida)

3.2.3.1. Emphasis in mechanical systems, materials, mechanics (statics & dynamics), control systems, energy, fluids, thermodynamics, heat transfer, transport phenomena, computational methods, finite element modeling, and robotics.

3.2.3.2. Provides fundamental academic framework for the study of firearms, ballistics, and shooting reconstruction.

3.3. Experience

3.3.1. Forensic Consultant, Knox & Associates, LLC (2010 - Present)

3.3.2. Police Officer / Detective, Jacksonville (FL) Sheriff's Office (1994 - 2010)

3.3.3. Patrol & DUI Enforcement (1994 - 2000)

3.3.4. Crime Scene Unit (2000 - 2007)

- 350+ forensic death investigations
- 200+ firearms death investigations
- Hundreds of shooting incident cases
- Responsible for gunshot residue collection in hundreds of firearms-related cases

3.3.5. Traffic Homicide Unit (2007 - 2010)

3.4. Professional Training Relevant to Firearms, Ballistics, and Crime Scene Reconstruction

3.4.1. Glock Advanced Armorer's Course, Glock Professional, Inc., 16 hours (Smyrna, GA, 2016)

3.4.2. Glock Advanced Armorer's Course, Glock Professional, Inc., 16 hours (Smyrna, GA, 2011)

3.4.3. Optics, Lighting & Visibility for the Forensic Investigator, Clearly Visible Presentations, 32 hours (West Chester, OH, 2011)

3.4.4. Glock Armorer's Course, Glock Professional, Inc., 8 hours (Smyrna, GA, 2011)

3.4.5. Collision Reconstruction Using PhotoModeler, EOS Systems, Inc., 24 hours (Chicago, IL, 2009)

3.4.6. Homicide Investigation, IPTM, 40 hours (Jacksonville, FL, 2006)

3.4.7. Advanced Bloodstain Pattern Analysis, IPTM, 40 hours (St. Petersburg, FL, 2006)

3.4.8. Crime Scene Reconstruction of Shooting Incidents, IPTM, 40 hours (Maitland, FL, 2006)

3.4.9. Firearms Instructor, Northeast Florida Criminal Justice Training Center, 44 hours (Jacksonville, FL, 2005)

3.4.10. Digital Photography for Law Enforcement, IPTM, 24 hours (Jacksonville, FL, 2005)

3.4.11. Bloodstain Pattern Analysis, IPTM, 40 hours (St. Petersburg, FL, 2003)

3.4.12. Crime Scene Reconstruction, IPTM, 40 hours (Jacksonville, FL, 2002)

3.4.13. Scene Mapping Using Speed Lasers, IPTM, 40 hours (Jacksonville, FL, 2001)

3.4.14. Light Energy Applications for Law Enforcement, IPTM, 24 hours (Jacksonville, FL, 2001)

3.4.15. Crime Scene Processing Workshop, IPTM, 40 hours (Jacksonville, FL, 2000)

3.4.16. Crime Scene Techniques for Buried Bodies & Surface Skeletons, IPTM, 40 hours (Jacksonville, FL, 2000)

3.4.17. Basic Evidence Technician, Northeast Florida Criminal Justice Training Center, 40 hours (Jacksonville, FL, 1996)

3.5. Certification & Accreditation

3.5.1. Certified Crime Scene Reconstructionist, International Association for Identification, Crime Scene Certification Board, Certification No. 3024 (Certified 2011, Renewed 2016, Expires 2021)

3.5.1.1. Certification and recertification testing included interpretation of GSR evidence.

3.5.2. Certified Glock Pistol Armorer, Glock Professional, Inc. (Certified 2011, Renewed 2016, Expires 2021)

3.6. Teaching

3.6.1. Adjunct Professor of Criminal Justice, Flagler College, 2017-Present

3.6.2. Adjunct Instructor, Forensic Technology, Institute of Police Technology & Management, 2009-Present

3.6.3. Adjunct Instructor, Forensic Technology, Keiser University, 2012

3.6.4. Contract Instructor, U. S. Department of State/International Narcotics & Law Enforcement Program, Tbilisi, Georgia, 2011

3.6.5. Contract Instructor, Crime Scene Technology, Sirchie Fingerprint Laboratories, 2010

3.7. Peer-Reviewed Publications

3.7.1. Knox, Michael A. "Forensic Engineering Analysis Methods Employed for the Purpose of Determining the Location of a Long-Range Shooter Based on Terminal Bullet Trajectory." Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition, November 15-21, 2013, San Diego, California. New York: American Society of Mechanical Engineers.

3.7.2. Knox, Michael A. "Forensic Analysis of an Accidental Firearm Discharge Due to a Blow to an Exposed Hammer Spur." Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition. November 9-15, 2012, Houston, Texas. New York: American Society of Mechanical Engineers, 2012.

3.7.3. Knox, Michael A. "Forensic Engineering Analysis of Ejected Cartridge Case Patterns for the Reconstruction of Firearms-Related Incidents." Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition. November 9-15, 2012, Houston, Texas. New York: American Society of Mechanical Engineers, 2012.

3.7.4. Knox, Michael A. "Multivariable Monte Carlo Analysis Methods in Traffic Accident Reconstruction Using Python." Proceedings of the ASME 2011 International Mechanical Engineering Congress & Exposition. November 11-17, 2011, Denver, Colorado. New York: American Society of Mechanical Engineers, 2011.

3.7.5. Knox, Michael A. "Forensic Engineering Applications in Crime Scene Reconstruction." Proceedings of the ASME 2010 International Me-

chanical Engineering Congress & Exposition. November 12-18, 2010, Vancouver, British Columbia, Canada. New York: American Society of Mechanical Engineers, 2010.

3.8. Prior Testimony

3.8.1. My testimony as an expert in crime scene reconstruction and associated topics has been accepted in state courts in Florida, Georgia, Alabama, Texas, Mississippi, and Illinois.

3.8.2. My testimony as an expert in crime scene reconstruction and associated topics has been accepted in United States District Court in Alabama, Pennsylvania, Illinois, Minnesota, and Utah.

3.8.3. My testimony as an expert in crime scene reconstruction and associated topics has been accepted in United States military court.

3.8.4. The majority of cases in which I have testified as an expert in crime scene reconstruction have included analysis of gunshot residue as at least a tangential component of my analysis, reporting, and/or testimony.

3.8.5. A comprehensive list of prior expert testimony has been provided in a separate document.

3.9. Compensation

3.9.1. My rate for this case is $250 per hour for analysis, field work, testimony, and travel.

3.9.2. A copy of my current fee schedule has been provided in a separate document.

3.10. Additional Qualifications

3.10.1. With respect to GSR evidence, I have experience in hundreds of shooting cases in which I served as a crime scene investigator documenting and collecting GSR evidence at crime scenes and on individuals involved in shootings. Perhaps as many as one hundred times, I have used dabbers similar to those used to collect the GSR samples in this case.

3.10.2. As a crime scene reconstructionist, my role with respect to GSR is to interpret GSR findings in an investigative context to apply those results to the overall analysis of how a crime took place. I have been providing such analyses professionally since around 2002 when I was a police crime scene investigator. I have consulted on hundreds criminal and civil cases in which gunshot residue has been an issue with respect to the physical evidence.

3.10.3. I have significant experience reading and interpreting laboratory reports and bench notes regarding GSR analysis. My graduate coursework included the process of reading and interpreting SEM run sheets, as well as laboratory quality assurance and control. I have practical experience applying GSR results to actual cases in context of the other physical evidence.

3.10.4. To obtain and renew my certification as a crime scene reconstructionist, I was tested on GSR interpretation and application to casework.

3.10.5. Additional qualifications, including teaching experience and publications are outlined in my current curriculum vitae.

4. Scientific Basis for the Role of Gunshot Residue in Crime Scene Reconstruction

4.1. The Association for Crime Scene Reconstruction defines the purpose of crime scene reconstruction: "To gain explicit knowledge of the series of events that surround the commission of a crime using deductive reasoning, physical evidence, scientific methods, and their interrelationships."

4.1.1. The physical evidence used in the reconstruction of crime scenes includes gunshot residues.

4.2. The process of examining, analyzing, and reconstructing a criminal incident falls under the scientific discipline of forensic crime scene reconstruction.

4.2.1. Shooting incident reconstruction and bloodstain pattern analysis are subsets of the discipline of crime scene reconstruction.

4.2.2. GSR analysis is a consideration in almost every shooting incident reconstruction case.

4.3. Considered the father of modern criminalistics, Kirk (1974) explains how physical evidence is inextricably tied to those involved a criminal event:

4.3.1. "All criminal investigation is concerned with people and with things," writes Kirk. "Only people commit crimes, but they invariably do so through the medium of things" (p. 1).

4.3.2. "Wherever he steps, whatever he touches, whatever he leaves—even unconsciously—will serve as silent evidence against him. Not only his fingerprints and his shoeprints, but also his hair, the fibers from his clothes, the glass he breaks, the tool mark he leaves, the paint he scratches, the blood or semen that he deposits or collects—all these and more bear mute witness against him. This is evidence that does not forget. It is not confused by the excitement of the moment. It is not

absent because witnesses are. It is factual evidence. Physical evidence cannot be wrong; it cannot perjure itself; it cannot be wholly absent. Only in its interpretation can there be error. Only human failure to find, study, and understand it can diminish its value" (p. 2).

4.4. A crime scene is a static representation of a dynamic event. The physical evidence left at the scene at the conclusion of a criminal event is the culmination of evidence deposited over the course of time. The crime scene has four dimensions:

4.4.1. width;

4.4.2. height;

4.4.3. depth; and,

4.4.4. time.

4.5. The deposition of evidence, including GSR, at a crime scene is a mechanical process controlled strictly by the laws of physics commonly applied in engineering practice.

4.6. Competent crime scene reconstructionists have appropriate education and training in many aspects of forensic science, including the analysis of GSR results in an investigative context.

4.6.1. Chisum and Turvey (2007) argue that crime scene reconstructionists should be forensic generalists: "[W]e do not propose that to perform crime reconstruction one needs to be an expert in all forensic disciplines. We propose that forensic reconstructionists must become an expert in only one: the interpretation of the evidence in context" (p. xviii).

4.7. Houck (2011) argues that forensic science is a separate basic science, rather than simply an applied science, because "it deals with topics and combinations of topics that no other science does." Houck defines forensic science as "the science of spatial and temporal relationships between people, places, and things involved in crimes." Forensic science, much like geology, astronomy, archeology, and paleontology, is a historical science that deals with proxy data. "The events under study have already occurred and are in the past," Houck explains. "A forensic scientist does not view the crime as it occurs [but] must assist the investigation through the analysis of the physical remains of the criminal activity."

4.7.1. Likewise, GSR analysis involves an analysis of the remnants of criminal activity.

4.8. The crime scene reconstructionist deals in time periods that are much shorter than most other scientists relying on proxy data, but he or she must also deal in details that are significantly more fine than those of other proxy-data scientists. The archeologist, for example, may deal in time spans of hundreds or even thousands of years, but will likely be dealing in much grosser detail than the forensic scientist. The archeologist will view the collective actions of a group whereas the crime scene reconstructionist will view the minute actions of individuals. "Because of this abstraction," Houck explains, "we can only test hypotheses about what could have produced the proxy data we see. We cannot test the actual events that did produce that data." Hence, we meet one of the limitations of crime scene reconstruction: that definitive conclusions are often beyond our grasp. We are limited, as Houck explains, by the asymmetry of time: the past cannot be undone.

4.8.1. GSR analysis is likewise limited by the fact that analysts can only see what remains at the time of sampling, not necessarily what remained immediately after the shooting took place.

4.9. French criminologist and forensic science pioneer Dr. Edmond Locard developed the founding principle of forensic science, which has become known as the Locard Exchange Principle: every contact leaves a trace. Locard theorized that whenever a person commits a crime, that person leaves behind some item of evidence at the crime scene that was not there prior to the suspect's arrival, and, likewise, takes away something that was there before (James & Nordby, 2009, p. 169; Fisher, 1993, p. 165).

4.9.1. While the Locard Exchange Principle provides a generalized theory of physical evidence transfer between a crime scene and an individual who enters that scene, it is proven law and should not be so construed as to mean that physical evidence transfers are inevitable. Indeed, many transfers of physical evidence, including fingerprints, hairs and fibers, and GSR are limited by both aleatory and epistemic uncertainty, i.e., they are affected by both "noise" (randomness) in the system and by limitations in the evidence collection and analysis tools available.

4.10. The scientific discipline of forensic crime scene reconstruction applies widely-held principles from the physical and natural sciences to the physical evidence as it is found at a static crime scene in order to determine how that evidence was deposited and to reconstruct the events involved. Crime scene reconstruction is performed given the full context of evidence available to the forensic consultant at the time that the analysis is performed, including physical, documentary, and testimonial evidence. Crime scene reconstruction is an organized, logical process of arriving at proper, scientifically supported conclusions about the events surrounding the creation of the crime scene being examined.

4.10.1. GSR analysis is one component of a crime scene reconstruction in firearms-related cases.

4.11. Crime scene reconstruction is a scientific, logical method of reaching conclusions about fundamental questions based on certain inferences that may be drawn from the known facts. Very seldom will the practitioner be able to reach definitive, clear-cut answers that are unencumbered by any degree of uncertainty. Crime scene reconstructionists often deal in probability rather than certainty. However, when the practitioner takes all known facts into account with a clear head and open mind, he or she is often able to reach valid, usable solutions to crime scene problems.

4.12. The quality of a crime scene reconstruction is proportional to the number of available pieces. If enough pieces exist that the gaps in the picture can be effectively interpolated, then a proper crime scene reconstruction can be performed. The more pieces that are known, the more complete the picture. No matter what information exists, however, the overriding factor that should be foremost in the mind of a crime scene reconstructionist is the belief that whatever analysis is performed is only as good as the context in which it is considered.

4.13. A number of authors have written on the topics of shooting incident and crime scene reconstruction (including analysis of GSR). A list of publications on these and related topics has been included as an appendix to this report.

5. Items Reviewed

5.1. Documents and Information Supplied by Counsel:

5.1.1. Court Documents:

5.1.1.1. Complaint

5.1.1.2. Petition for Writ of Actual Innocence (Burgess 927-970)

5.1.2. Deposition Transcripts:

5.1.2.1. Sabein Burgess

5.1.2.2. Robert Collins

5.1.2.3. Daniel Van Gelder

5.1.2.4. Victor Meinhardt

5.1.2.5. Dale Weese

5.1.3. Expert Reports:

5.1.3.1. Wayne Niemeyer

5.1.3.2. John Kilty (Affidavit & Report)

5.1.3.3. Joseph Stine

5.1.4. Forensic Reports:

5.1.4.1. Report and bench notes by Daniel Van Gelder (35 pages) (Individual Defendants 6910-6944)

5.1.4.2. BPD Mobile Unit Report re: GSR Collection (3 pages) (Burgess 112-114)

5.1.4.3. GSR collection form (2 pages) (BPD 2684-2685)

5.1.5. Photographs:

5.1.5.1. Photographs showing Burgess's hands (2) (Burgess 973-974)

5.1.5.2. Photographs showing GSR collection kit (7) (Individual Defendants 10225-10231)

5.1.6. Trial Testimony:

5.1.6.1. Daniel Van Gelder (Burgess 1161-1204)

5.1.6.2. Victor Meinhardt (Burgess 1123-1158)

5.1.7. Other Documents:

5.1.7.1. State's Attorney's handwritten notes (46 pages) (Burgess 3768-3835).

6. Background

6.1. On October 5, 1994, the body of Michelle Dyson was found in the basement of the residence at 2703 Barclay Street in Baltimore, Maryland.

6.2. Sabein Burgess, Dyson's boyfriend, was present in the basement with Dyson when police arrived.

6.3. Police ultimately charged Burgess with Dyson's murder. Burgess of convicted of the murder and spent nearly 20 years in prison before his conviction was vacated, charges were *nolle prossed*, and Burgess was released from prison.

6.4. Burgess brought a claim in U. S. District Court against the Baltimore Police Department and several employees who were involved in the investigation.

6.5. Knox & Associates, LLC, was retained on or about October 30, 2016, to provide analysis with respect to the sampling and investigative interpretation of test results with respect to GSR on Burgess's hands.

7. Gunshot Residue Collection & Analysis

7.1. GSR samples are typically collected from an individual who is possibly connected with a firearms-related crime.

7.2. GSR sampling may be done at or near a crime scene, at a police facility, at a morgue, at a hospital, or at some other location.

7.3. GSR sampling is often one of the first processes a crime scene investigator carries out after arriving at a crime scene.

7.4. The proper procedure for collecting GSR samples in 1994 was the following:

7.4.1. A crime scene investigator would typically use a kit obtained from a forensic equipment supplier. The kits would usually contain an envelope for retaining the samples, two or four plastic vials with removable lids with adhesive material on the inside surface of the lid (typically called a dabber), a collection form with instructions, a pair of plastic gloves (similar to those often worn by food servers), and evidence tape for sealing the envelope.

7.4.2. The crime scene investigator would fill out the collection form, which included general information about the case and the individual from whom the samples were collected.

7.4.3. The crime scene investigator would don the gloves and use each dabber to sample the designated areas of the hand. Two-dabber kits instructed the investigator to sample the surface on the back of each hand (using separate vials) covering the area on the dorsal surface of the hand including the proximal phalanx of the index finger, the proximal phalanx of the thumb, and the surface in between, including the webbing. Four-dabber kits instructed the investigator to additionally sample the palm of each hand covering the area on the palmar surface of the hand including the proximal phalanx of the index finger, the proximal phalanx of the thumb, and the surface in between, as well as the area proximal to each finger.

7.4.4. The dabbers were used one at a time. Each dabber was dabbed numerous times in rapid succession as the dabber is slowly moved across the areas of the hand to be sampled. The dabber was returned to its vial before the next dabber was used, so no two dabbers were ever out of their respective vials at the same time.

7.4.5. Once all the samples (two or four) had been collected, the dabbers vials were returned to the envelope, which was sealed with evidence tape and submitted as evidence to the police evidence locker or property room.

7.4.6. The envelope containing the samples was later delivered to the crime laboratory where the dabbers were analyzed using a scanning electron microscope. The results were then reported by the laboratory analyst, typically to the detective in charge of the investigation.

7.4.7. In court, the crime scene investigator will typically testify as to the collection process, and the laboratory analyst will typically testify as to the laboratory procedures and testing results.

7.5. As evidenced in the documents provided for my review, the procedure in place in 1994 for the Baltimore Police Departament was consistent with the procedure outline, *supra*.

8. Deposition Testimony

8.1. Victor Meinhardt

8.1.1. Victor Meinhardt was a crime scene investigator with the Baltimore Police Department. He processed the crime scene and collected the GSR samples from Sabein Burgess's hands.

8.1.2. While Meinhardt had no independent recollection of the evidence collection and his trial testimony in this particular case, he testified at his deposition that he dabbed the webbing of Burgess's hands (Meinhardt Deposition, pp. 66-67, 132-135).

8.1.3. Meinhardt's testified that he was trained to dab the webbing of the hand between the thumb and the index fingers (pp. 164, 166-168, 171, 173).

8.1.4. Meinhardt was asked to list the reasons why he believed he "swabbed the area between Mr. Burgess's thumb and forefinger as opposed to the inside of his palms." Meinhardt answered: "Because that's how I was trained. That's how I remember always doing it, and I have no recollection of ever swabbing anyone's palm" (p. 173).

8.1.5. Meinhardt also testified that he had no recollection of ever discussing the case with Van Gelder (p. 164).

8.1.6. Meinhardt testified that he was aware that GSR could be transferred, but he was not sure if he had been aware of that possibility in 1994 when he sample Burgess's hands (p. 146).

8.2. Robert Collins

8.2.1. Robert Collins was a crime scene investigator with the Baltimore Police Department. He assisted Meinhardt with processing the murder scene.

8.2.2. Collins attended a two-week training program prior to October 1994 in which he was trained on GSR collection procedures (Collins Deposition, p. 12).

8.2.3. Collins testified that he was trained to follow the steps on the GSR collection form when obtaining GSR samples from people's hands (pp. 80-81, 84).

8.2.4. Collins testified that it would have been unusual for him to collect GSR samples following any procedure other than what was depicted on the GSR collection form (pp. 92-93).

8.2.5. Collins photographed Burgess's hands and noted that he saw blood on them. He did not recall whether the photographs were taken before or after the GSR samples were collected (p. 44).

8.2.6. Notes from the investigation indicate that the GSR samples were collected at 11:05 p.m.; Burgess's sweatshirt, coat, and cap were taken for evidence; and photographs were taken at 11:13 p.m. (BPD 002656).

8.2.7. Collins searched the scene for a firearm but did not find one (pp. 47-49).

8.3. Daniel Van Gelder

8.3.1. Daniel Van Gelder was a criminalist for the Baltimore Police Department. He performed the analysis on the GSR samples, reported on the results, and testified at Burgess's criminal trial.

8.3.2. Van Gelder had a Bachelor's degree in physics and a Master's degree in forensic science, both of which he earned well before the Burgess case (Van Gelder Deposition, pp. 6-7).

8.3.3. Van Gelder went to work for the Baltimore Police Department in 1972 as a crime scene investigator (crime laboratory technician)(pp. 13, 28-29).

8.3.4. When Van Gelder was a crime scene investigator, the Baltimore Police Department was not doing GSR testing. Van Gelder began doing GSR analysis in 1991 when the BPD started doing SEM analysis on GSR samples (pp. 31-32).

8.3.5. Van Gelder was the primary person with duties of training crime scene technicians at the BPD in the process of collecting GSR samples using adhesive dabbers (pp. 39-40).

8.3.6. Van Gelder testified that, prior to analyzing GSR samples, it was his practice to review the mobile crime lab report and photographs. It was typically not his practice to review the autopsy report, primary because they were not "easily available." Van Gelder explained: "We're just a laboratory. So we base our laboratory reports on what we can find out from our own examinations" (pp. 85-87).

8.3.7. Van Gelder explained that, when he would receive a request to perform GSR analysis, he would not typically know from whom the GSR samples had been taken (i.e., victim, suspect, etc.) (p. 90).

8.3.8. Van Gelder testified that his understanding of the Locard Exchange Principle was that it was a general principle—that a person visiting a crime scene would "exchange something with the crime scene," not necessarily that two items coming into contact would transfer something to one another (pp. 97-98).

8.3.9. According to Van Gelder, at the BPD in 1995, it would have been the judgment of the criminalist conducting the GSR analysis to determine if there was a positive finding of GSR (pp. 131-132).

8.3.10. While Van Gelder had not reviewed any publications regarding transference of GSR in advance of his recent deposition, he acknowledged

that, given the circumstances of this case, it was possible that GSR particles transferred from the victim to Burgess's hands when he cradled her head (p. 147). However, Van Gelder clarified: "[J]ust because he does what you said he did, that doesn't mean that necessarily there was some transfer" (p. 148).

8.3.11. Van Gelder testified that it is his belief that additional empirical research is needed to understand GSR transfer from one object to another (p. 149).

8.3.12. Van Gelder testified that it was his belief that GSR could transfer with blood when blood was wet (p. 161).

8.3.13. Van Gelder testified that there was "a possibility the residues were transferred from the surface of a firearm or from an object which lay immediately adjacent to the firearm during its discharge, such as the victim" (p. 231). He confirmed his belief in his trial testimony that there was "a very small possibility" of transfer (p. 232).

8.3.14. Van Gelder confirmed his trial testimony that it was "very probable" that Burgess either fired a gun or had his hands in close proximity to a gun when it was fired. He indicated that, in his mind, the terms "very probable" and "most probable" are "in the same ballpark" (p. 245).

8.3.15. According to Van Gelder, his conclusion in this case was based on a number of factors including, but not limited to, his belief that more gunshot primer residues are expelled from the breech of a gun than from the muzzle (pp. 247-249).

8.3.16. Van Gelder testified that it was his normal practice to examine GSR dabbers for contamination under a stereomicroscope before running the SEM analysis on the dabber (p. 102).

8.3.17. Van Gelder testified that his testing revealed a total of 197 particles associated with GSR on the sample from Burgess's right hand (pp. 182-209).

8.3.17.1. Fifteen particles consisted of lead (Pb), barium (Ba), and antimony (Sb).

8.3.17.2. Eighty-one particles consisted of lead (Pb) and antimony (Sb).

8.3.17.3. Eleven particles consisted of lead (Pb) and barium (Ba).

8.3.17.4. Eleven particles consisted of barium (Ba) and antimony (Sb).

8.3.17.5. Seventy-nine particles consisted of lead (Pb).

8.3.18. Van Gelder testified that his testing revealed a total of 44 particles associated with GSR on the sample from Burgess's left hand (pp. 182-209).

8.3.18.1. Three particles consisted of lead (Pb), barium (Ba), and antimony (Sb).

8.3.18.2. Eight particles consisted of lead (Pb) and antimony (Sb).

8.3.18.3. Four particles consisted of lead (Pb) and barium (Ba).

8.3.18.4. One particle consisted of barium (Ba) and antimony (Sb).

8.3.18.5. Twenty-eight particles consisted of lead (Pb).

8.3.19. In total, Van Gelder found 241 particles associated with GSR on the two samples from Burgess's hands.

8.3.20. Van Gelder defined the amount of gunshot residue found on Burgess's left hand as "a lot," but he clarified that that opinion was based on his experience in 1995; improvements in the SEM technology have made GSR detection much better (p. 250).

8.3.21. Van Gelder testified that the presence of 15 three-component particles of GSR is "an awful lot" (p. 251).

8.3.22. Van Gelder testified at trial that there was "a very small possibility" that the particles had been transferred to Burgess's hands (pp. 231-232; see also Criminal Trial Transcript, pp. 220-221).

8.3.23. In 2001, Van Gelder expressed concerns at a BPD meeting that "over-valuing the results of the GSR test or the probability that a person was shooter" was of concern with respect to convictions based solely on GSR testing (pp. 309-310).

9. Literature Review

9.1. When considering the question of scientific appropriateness of Van Gelder's analysis, report, and testimony with regard to the GSR findings in this case, it is imperative that one review the body of published empirical scientific research and textbook literature on the topic.

9.2. Empirical Literature (Through 1995)

9.2.1. Wolten, Nesbitt, and Calloway (1979) studied 72 actual firearms-related criminal cases and found that GSR was detected in 88% of cases. According to the authors, GSR "can be found on a person's hand not only if the subject fired a gun, but also if he handled a recently fired gun or was a close bystander at a shooting" (p. 868). The authors did

not address the possibility of transfer of GSR from a victim to a subject's hands.[1]

9.2.2. Studying actual casework in Israel between 1989 and 1994, Zeichner and Levin (1995) found that positive findings of GSR on samples taken from the hands, hair, or clothing of a shooting suspect occurred in only about 13% of cases. Of the positive samples, 39% had only one particle, 44% had between two and five particles, and only 17% had more than five particles.

9.3. Empirical Literature (Post-1995)

9.3.1. Basu et al. (1997) studied the transfer of GSR to a non-shooter who handled the firearm after it was discharged. The researchers wrote: "The trigger-blast residues are literally sprayed onto the back of the shooter's hand(s). This has the advantage that one can distinguish the shooter from a non-shooter" (p. 576).

9.3.2. Wright and Trimpe (2005) reported on the proceedings of an FBI symposium on GSR.

9.3.2.1. Among their discussion was a recitation of numerous studies that were reported by symposium participants regarding the possibility of contamination of subjects from police vehicles, officers, and facilities. It was reported that the U.S. Army Crime Laboratory required a threshold level of four PbBaSb particles to report a positive finding of GSR, while the FBI laboratory required the presence of a threshold level of three PbBaSb and the presence of other SbBa, BaPb, and/or PbSb particles to report a positive finding. The

[1] Plaintiff's expert Wayne Niemeyer listed this paper as a reference but did not expressly cite it in his report.

threshold levels were established "to allow for the possibility of casual contact by subjects with firearms in the performance of their duties." The group concluded that "levels beyond this [threshold] value would likely involve greater exposure to GSR particles, namely the recent discharge of a firearm." The authors also reported on a 2004 study in which it was determined that, due to the variability in GSR deposition, "the number of GSR particles cannot be used as a basis for determining if someone fired, or was merely in the vicinity of, a recently discharged firearm."

9.3.2.2. Wright and Trimpe also discussed the issue of testing victims of suspected suicides.

- "Particles are expected to be found on a victim shot at close range," the authors wrote, "or within a reasonable distance from the muzzle, up to several feet."

- "Depending on the circumstances," the authors reported, "some victims near [a] shooting may not have GSR particles on them."

- The authors reported on a 10-year study in Virginia in which 13% of the 2,040 possible suicide victims studied did not have GSR detected on their hands. The authors reported on several other studies with similar results.

- The authors reported on a Colorado Bureau of Investigation database tracked "the rate of positively confirmed GSR on victims of fatal gunshot wounds" in

which the data showed that least one PbBaSb particle had been found on 80% of homicide victims.

9.3.2.3. The authors reported that the consensus among symposium participants was that GSR cannot be used to distinguish between a shooter and a bystander.

9.3.2.4. Wright and Trimpe did not report on any studies regarding the probability of transfer of GSR from a victim to a subject's hands.

9.3.2.5. Wright and Trimpe reported on the FBI's decision to stop accepting GSR samples for testing. "This decision was made after an internal assessment of the number of requests received," the authors wrote, "and the probative nature of those requests." While the FBI laboratory "continues to believe that the GSR examination is valuable," the decision was made to shift resources "to fighting terrorism, which is the FBI's primary mission."

9.3.3. Studying the potential for GSR transfer from police vehicles and facilities, Berk et al. (2007) found that, though transfer could occur, the probability of it occurring was "relatively low" (p. 841).

9.3.4. Studying the distribution of antimony particles on a shooter, Brozek-Mucha (2009) found that the frequency of occurrence was about 78% for the shooter's hands in contrast with 39% for the sleeves, 41% for the front of the clothing, and 37% for the back of the clothing.

9.3.5. According to Brozek-Mucha (2011), "studies on the persistence of GSR concentrated mainly on the shooter's hands because the greatest amount of particles settle on the shooter's hands" (p. 973). Further-

more, Brozek-Mucha found that initial numbers of particles on the face and hair were much lower than on the shooter's hands, but that the particles persisted on the face and hair for a much greater period of time than they did on the shooter's hands.

9.3.6. Lindsay et al. (2011) studied the GSR present on bystanders to shootings and found that the numbers of particles on the shooters were significantly greater than were the number of particles found on the bystanders, but the authors cautioned that, when the particle numbers are low, it may not be possible to distinguish between a shooter and a bystander. However, it must be noted that in all of their test cases, the bystanders were present when the shots were fired.

9.4. Textbook & Training Literature (Through 1995)

9.4.1. Writing about gunshot residue detective using the paraffin test, O'Hara and O'Hara (1988) stated that "a positive reaction is interpreted as proof that the hand was used in the discharge of a gun" (p. 822).

9.4.2. Aaron (1991) wrote: "A person can pick up GSR simply by handling a dirty weapon or discharged ammunition components. It is also possible, *but very unlikely*, that residue would be deposited on hands by other means. Thus, placing an individual in an environment of GSR generally puts that person in the presence of a firearm" (p. 21, emphasis added). Furthermore, Aaron wrote: "The detection of gunshot primer residue on the hands of an individual confirms that this person was in an environment of the material within a few hours preceding the collection of samples. This would likely result from firing a weapon or ammunition, or being in close proximity to a weapon as it is discharged by another person" (p. 22).

9.4.3. Osterburg and Ward (1992, p. 128) provided two paragraphs of discussion regarding GSR traces on a subject's hands but did not address the potential for transfer from a victim to a subject's hands.

9.4.4. With respect to interpreting the results of GSR testing, Fisher (1993) explained that a "positive test result means that the subject fired a weapon sometime during the past six hours (approximately), or handled a weapon during that time period" (p. 279). Fisher makes no mention of transfer of GSR particles from a victim to a subject's hands.

9.5. Textbook & Training Literature (Post-1995)

9.5.1. Geberth (1996) wrote: "A positive test [for GSR] shows that a subject was in the vicinity of a gunshot, as long as they were not cross-contaminated" (p. 200). Geberth provided no further discussion of cross-contamination and no discussion of the potential for transfer from a victim to a subject's hands.

9.5.2. Di Maio (1999) explained that, to "correctly interpret the significance, if any, of a positive result, one must take into account the surface area of the hand that is positive" and "the nature of the weapon" (p. 331). Di Maio reported on the relatively low probability of obtaining a positive GSR sample from a known shooter and explained that "a negative test for gunshot residue is meaningless. It does not prove that an individual did not fire a weapon" (p. 334). While Di Maio mentioned that a "positive test for gunshot residues on the hands can result from handling a weapon that has been recently discharged," he did not provide a statement as to the probability of GSR particles being transferred to a subject's hands by means of touching a gunshot victim.

9.5.3. Schwoeble and Exline (2000) provided perhaps the most lengthy text-book discussion of GSR transfer, but the authors did not provide any quantitative or pseudo-quantitative probability that GSR particles could be transferred from a victim to a subject's hands.

9.5.4. Hueske (2006) explained that "finding primer residues on a suspect must not be construed to mean that the suspect fired a weapon as opposed to merely being in close proximity when a weapon was discharged or handling a weapon that had residues" (pp. 136-137). Hueske also suggested that "theoretically" GSR could be transferred to a subject's hands during the arrest process, and he wrote that "a transfer can occur from contacts between two surfaces" (p. 137). He did not provide any discussion as to the probability of such transfers.

9.5.5. Thornton and Kimmel-Lake (2007) wrote: "If the hands of a subject are tested and show [GSR] particles, it is consistent with the following: (1) The person has recently discharged a firearm, (2) has been in close proximity . . . to a firearm when it was discharged, (3) has handled a firearm or other object that was contaminated with gunshot residue particles from a previous or subsequent gunshot discharge, or (4) was in a room for a long period of time in which a firearm had recently been discharged" (pp. 207-208). The authors did not address the relative probabilities of the four stated explanations.

9.5.6. Heard (2008) characterized a finding of GSR particles on the backs of both of a subject's hands as "highly indicative of the person having fired a weapon in that hand" (p. 253). Heard, referring to alternative sampling sites on the clothing, face, or hair of a shooter, explained that "GSR vented from the breech end of a pistol is of low velocity and as such, particles can only be found on the surfaces immediately sur-

rounding the breech of the weapon, that is, the hands" (pp. 259-260). Heard did not mention the probability (or even possibility) of GSR being transferred from a victim to a subject's hands.

9.5.7. Wallace (2008) addresses the possibility of GSR transfer, but does so in a context of interpreting patterns of GSR when time has passed since the shooting took place. Wallace did not provide any quantitative or pseudo-quantitative probability that GSR particles could be transferred from a victim to a subject's hands.

9.5.8. Writing on the topic of microanalysis, Kubic and Petraco (2009) explained that "[p]ractitioners' opinions vary concerning the number of particles and composition required to determine that a sample is truly GSR." They went on to explain that "[c]onsideration should be given to the location from which the sample was collected—for example, the web of the hand or the palm. The goal of unambiguously placing a particular weapon into the hands of a particular individual still remains to be attained" (p. 351). The authors did not mention the possibility of contamination from a victim to a subject's hands.

9.5.9. Noedel (2009) wrote: "Interpretation of the meaning of a positive or negative result for these particles is subjective; finding these particles cannot identify a shooter and the absence of these particles cannot eliminate a shooter. Each result must be considered in context with the event being investigated" (p. 169).

9.5.10. Rowe (2009), writing about firearms discharge residues, including primer residues, did not mention primer residues on the hands of a subject, nor did he address the probability of particle transfer from a victim to a subject's hands.

9.5.11. Haag and Haag (2011) pointed out that the "typical reporting language" for U.S. crime laboratories for a positive finding of GSR is to state that the subject "'either fired a gun, handled a gun, or was in close proximity to a firearm when it was discharged.'" The authors recommend the use of GSR sampling and testing in cases in which "the interval between the incident and the collection is short" and "*where the individual denies owning a gun, shooting a gun, handling a gun, or being anywhere near the discharge of a gun or at the immediate scene of a shooting. In this situation a positive result would be very incriminating*" (p. 101, emphasis added). The authors suggested contamination from an officer's hands or the inside of a patrol vehicle could be a factor, but they did not address the probability or even possibility of a transfer from a victim to a subject's hands.

9.5.12. According to Trimpe (2011), GSR particles "can transfer from a surface or person to another individual; the amount depends on the number of GSR particles on the contaminated surface . . . *and likely will be a small number of the total particles present*" (p. 26, emphasis added).

9.5.13. Warlow (2012) discusses the possibility of GSR transfer from a crime scene investigator or police vehicle to a subject, but does not discuss the probability of such transfer, nor the possibility of transfer from a victim to a subject's hands.

9.5.14. Nordby (2013) wrote: "GSR exiting the weapon can also be found on the face, hands, and clothing of anyone near a firearm's discharge, including the shooter himself. It may be transferred after a weapon's discharge through contact with the weapon" (p. 210). Nordby did not address the potential for transfer from a victim to a subject's hands.

9.6. Guidelines

9.6.1. Scientific Working Group for Gunshot Residue (SWGGSR)

9.6.1.1. The Scientific Working Group for Gunshot Residue (SWGGSR) was formed in 2005 (see http://www.swg-gsr.org), a full decade after Van Gelder's report and trial testimony in this case. "The mission of SWGGSR is to make recommendations for internationally accepted guidelines for the forensic examination of gunshot residues."

9.6.1.2. SWGGSR's 100-page guidelines address the possibility of transfer and includes "coming into contact with a surface that has GSR on it" as a possible explanation for GSR on a person's hands but instructs examiners to consider the "extent to which the examination can or cannot determine the relative likelihood of how or when the particles were deposited onto the hands" (Scientific Working Group for Gunshot Residue, 2011, p. 26).

9.6.1.3. The guidelines also state: "It is not usually possible to distinguish GSR particles deposited due to firing from residue deposited by being close to a discharge or through contact with a surface that has GSR on it" (p. 27).

9.6.1.4. The guidelines further clarify that the "presence of gunshot primer residue on a person's hand is consistent with that person having discharged a firearm, having been in the vicinity of a firearm when it was discharged, and/or having handled an item with gunshot primer residue on it" (p. 76).

9.6.1.5. In weighing these three possible explanations, the guidelines advise: "The [examiner] should not give undue weight to one conclusion over another. The significance of any finding is dependent on the circumstances of any case" (p. 76).

9.6.2. ASTM E-1588

9.6.2.1. ASTM International (formerly known as the American Society for Testing and Materials) created ASTM E-1588-94 that sets standards for laboratory handling of GSR samples and identification of GSR particles. These guidelines do not address the investigative interpretation of GSR results and provide no discussion regarding the possibility of GSR transfer or the applicable reporting and testimony language that should be used with respect to GSR findings.

9.7. The textbook references to GSR transfer to this day do not indicate that transfer from a victim to a subject's hands is likely to occur. Neither Chisum and Turvey (2007), Di Maio (1999), Fisher (1993), Gardner and Bevel (2009), Geberth (1996), Haag and Haag (2011), Heard (2008), Hueske (2006), James and Nordby (2009), Nordby (2013), O'Hara and O'Hara (1988), Osterburg and Ward (1992), Schwoeble and Exline (2000), Wallace (2008), Walton (2006), nor Warlow (2012) provides any quantitative or pseudo-quantitative probability of a transfer of GSR particles from a victim to a subject's hands, and most of those texts make no mention of even the *possibility* of such contamination.

9.8. Evident throughout both the empirical and textbook literature is the overarching concern for the loss of GSR particles that could result in a false negative and for the improvement of sampling procedures to prevent epistemic failures of the process to detect GSR particles on individuals who have, in fact, discharged a

firearm. Very little attention has been paid to the concept of transfer, particularly transfer of particles from a shooting victim to particular locations on the hands of a suspected shooter.

10. Analysis

10.1. Probability of Gunshot Residue Transfer

10.1.1. Simply stating that transfer was possible provides no measure of its probability. In statistical terms, the fact that transfer is possible leads only to the mathematical conclusion that $p_{transfer} > 0$. The combined probability of the three commonly-accepted possibilities for GSR being present on a subject's hands (fired a gun, was present when a gun was fired, and transfer) can be mathematically expressed as $p_{fired} + p_{present} + p_{transfer} = 1.0$.

10.1.2. Despite its paucity with regard to the issue of transference from secondary sources, the extant scientific literature to date solidly supports the contention that such transfers occur with much lower probability than does deposition of gunshot residues on the hands due to discharging a firearm. Given the fact that the empirical literature also strongly indicates that positive occurrences of gunshot residue particles in actual casework may be as low as 10%, the probability of a transfer of gunshot residue particles being detected in actual casework, the detection of nearly 200 particles associated with gunshot primer residue would appropriately be classified as "a very small possibility."

10.2. Plaintiff's Experts Opinions

10.2.1. Wayne Niemeyer

10.2.1.1. Niemeyer referred to the Locard Exchange Principle in explaining the transfer of GSR particles. First, the Locard Exchange Principle is a general principle used to explain evidence transfer; it is far from proven law. Second, the Locard Exchange Principle does not in any way provide a probability that 241 particles associated with GSR would be transferred from a victim to a subject's hands. The principle only states that *some trace evidence* would be transferred by such contact. That trace could occur in other forms, not necessarily GSR. Even if the principle were so construed as to mean that GSR transfer would occur in every contact, the principle does not provide guidance as to the quantity (or percentage) of particles that would be transferred. In fact, to know whether GSR would be transferred by a particular contact, one would have to know that the areas where GSR was located on a particular surface were touched, and that GSR was actually present on the surface from which GSR was believed to have been transferred. In this case, GSR transfer cannot be established scientifically; it can only be inferred from what we now know about this case.

10.2.1.2. Niemeyer wrote: "Due to many uncontrolled variables regarding GSR particle deposition and particle loss over time, one cannot scientifically (i.e. statistically) determine the relative likelihood of a person firing a gun, being in close

proximity to a gun when fired or coming into contact with a surface that has GSR on it" (Niemeyer Report, p. 3).

- This statement, particularly as it applies to Van Gelder's analysis in this case, is contradicted by the empirical, textbook, and training literature. The empirical literature quite clearly establishes that, although the probabilities of these three possibilities cannot easily be quantified, transfer depositions occur less frequently, and in smaller particle numbers, than do depositions due to firing or being in close proximity to a firearm when it is discharged. Hence, the relative probabilities are at least implicit in the research, even if the absolute probabilities are far from known.

- Furthermore, this statement contradicts Niemeyer's conclusion that transfer was "most likely" the reason for GSR being detected on Burgess's hands. If, as Niemeyer wrote, one "cannot scientifically . . . determine the relative likelihood" of the three possible explanations, how can Niemeyer determine that transfer was "most likely"?

10.2.1.3. Niemeyer stated his objection to Van Gelder's reported conclusion and trial testimony, opining that "Van Gelder's opinions had no scientific basis" (Niemeyer Report, p. 8). However, in supporting his conclusion, Niemeyer mischaracterized the basis for Van Gelder's conclusion by only stating that Van Gelder found 18 GSR particles. In fact, Van Gelder found 18 particles characteristic of GSR, but he also

found 223 particles consistent with GSR for a total of 241 particles associated with GSR (Scientific Working Group for Gunshot Residue, 2011, pp. 20-22).

10.2.1.4. Niemeyer listed seven references in his report, only four of which were published prior to Van Gelder's 1995 trial testimony (Aaron, 1991; Ravreby, 1982; Wolten, Nesbitt, & Galloway, 1979; Zeichner & Levin, 1993). None of the literature cited by Niemeyer provides any quantitative or pseudo-quantitative probability of GSR transfer from a victim to a subject's hands. None of the pre-1995 references admonish GSR analysts to consider transfer from a victim to a subject's hands as a possible explanation.

- Niemeyer cited ASTM E-1588-17, which is the current (2017) version of the standard that was originally published as ASTM E-1588-94 in 1994. The current standard does not address GSR transfer or the interpretation, reporting, or testimony with respect to the origin of GSR results in actual casework. Likewise, the 1994 version of the standard did not address these issues. Therefore, this reference provides no scientific support for Niemeyer's conclusions in this case.

- Niemeyer cited SWGGSR guidelines (Scientific Working Group for Gunshot Residue, 2011). As discussed, *supra*, these guidelines do not address the relative probabilities of GSR being present on a subject's hands due to firing a gun versus touching an object with GSR on it. Given the fact that SWGGSR was not formed until a

decade after Van Gelder's testimony in this case, these guidelines provide no scientific support for Niemeyer's conclusions.

- Niemeyer cited Zeichner and Levin (1993), an empirical study that focused on the collection of GSR particles from a subject's hair using double-sided adhesive tape. This study did not address the probability of transfer from a victim's hair (or any other part of a victim's body) to a subject's hands. This paper does not provide scientific support for Niemeyer's conclusions.

- Niemeyer cited Wolten, Nesbitt, and Galloway (1979), an empirical study that focused on particle analysis in GSR detection. This study addressed the possibility of transfer of GSR particles to a subject's hands from handling a firearm but did not address the possibility of GSR transfer from a victim to a subject's hands. This paper does not provide scientific support for Niemeyer's conclusions.

- Niemeyer cited Raverby (1982), an empirical study that focused on the analysis of bullet entrance holes in long-range shootings. The study did not even address gunshot primer residue on a person's hands and provides no scientific support for Niemeyer's conclusions.

- Niemeyer cited Aaron (1991), and FBI training bulletin article covering GSR. Aaron wrote that it was "possible" but "very unlikely" that GSR could be deposited on a person's hands by means other than firing a gun,

being near a gun when it was fired, or handling a gun or ammunition (pp. 21-22). This article contradicts Niemeyer's conclusions and supports Van Gelder's conclusions.

- Niemeyer cited Bisbing (2004), an article on the web-site for McCrone Associates, the company that employs Niemeyer. The article provides brief, general coverage of various microscopical analyses, including GSR. Bisbing discussed the Locard Exchange Principle, pointing out that Locard never referred to an "exchange principle" but wrote: "'It is impossible for a criminal to act, especially considering the intensity of a crime, without leaving traces of this presence.'" The article makes no mention of GSR transfer. Apart from providing a reference to the Locard Exchange Principle, this article provides no scientific support for Niemeyer's conclusions.

10.2.1.5. Niemeyer does not provide any quantitative or pseudo-quantitative probability of GSR transfer from a victim to a subject's hands. He stated only that "GSR particles can be easily transferred from one object to another during direct contact" (Niemeyer Report, p. 9). In fact, in his report Niemeyer used the word "possible" twice and "possibility" ten times, but never used the word "probable" or "probability" a single time. Mathematically, to state that something is "possible" is only to state that the probability of occurrence is not zero.

10.2.1.6. Niemeyer, despite not defining the probability of transfer, not citing any empirical literature that does define that probability, and asserting that "cannot scientifically . . . determine the relative likelihood" of either of three possible explanations he gave for GSR being detected on Burgess's hands concluded that transfer of the GSR was "most likely" and critiqued Van Gelder's testimony that transfer was "unlikely" as lacking any scientific basis.

10.2.1.7. Niemeyer concluded that Van Gelder's "statements that GSR particle transfer is very unlikely" were "completely wrong and entirely without scientific basis" (p. 9). Niemeyer's conclusion misstates Van Gelder's testimony. Van Gelder did not testify that GSR particle transfer was unlikely; he testified that *the quantity of GSR particles found on Burgess's hands* led him to conclude that transfer was "unlikely" in this case.

10.2.1.8. Nowhere in his report did Niemeyer establish that Van Gelder knew or should have known of anything other than the fact that transfer was possible. That fact does not seem to be in dispute in this case. What is in dispute is Van Gelder's testimony that transfer in this case was "unlikely." To that issue, Niemeyer did not establish through any scientific evidence that Van Gelder's conclusion and testimony in 1994 and 1995 were incorrect in light of the prevailing empirical, textbook, and training literature of the day.

10.2.1.9. Niemeyer did not conclude that Van Gelder had fabricated the GSR findings, his report, or his trial testimony.

10.2.2. John Kilty

10.2.2.1. Kilty opined that Burgess had been "in an environment where there was gunshot primer." Kilty offered several possibilities: "discharging a firearm, being in proximity of a discharging firearm, or touching and/or being touched by a person and/or object contaminated with gunshot primer residue." Kilty concluded: "I do not believe that the relative likelihood of any of these possibilities or combination of possibilities can be determined" (Kilty Report, p. 10).

- Kilty did not opine that he believed that Van Gelder should have viewed the evidence in the same light in 1994 when he issued his report or in 1995 when he testified at Burgess's criminal trial.

- In fact, in Burgess's Petition for Writ of Actual Innocence, Burgess argued specifically that Kilty opined that Van Gelder *would not have known* about concerns regarding GSR interpretation and revisions in GSR guidelines until at least after Burgess's 1997 deadline for filing a motion for a new trial.

10.2.2.2. Kilty stated only that GSR transfer was possible, which is to say that the probability of transfer was some non-zero value. Kilty did not establish that the probability was not "very small."

10.2.2.3. Kilty did not conclude that Van Gelder had fabricated the GSR findings, his report, or his trial testimony.

10.2.2.4. Kilty did not take issue with Van Gelder's GSR findings, but did conclude that the conclusion section of Van Gelder's report was "too restrictive" and "misleading" (p. 3).

- Kilty wrote: "In my opinion, there is no basis to conclude from all of the data that the most likely explanation for the presence of GSR is the firing of a weapon" (p. 3).
- Kilty also wrote that the conclusion section of Van Gelder's report "essentially limited [the reader] to accepting the conclusion that the person got the gunshot primer residue on his hands by discharging a firearm" (p. 9).
- However, Kilty's statements misrepresent Van Gelder's report (see discussion, *infra*), which states that *the combination* of two possible choices—that the subject's hands were either *immediately adjacent* to a firearm or *were used to discharge* a firearm—is most probable.

10.2.2.5. Given Kilty's assertions that the three possibilities were equally probable (Kilty Affidavit, p. 3), then the conclusion statement in Van Gelder's report was mathematically correct (see Conclusions, *infra*).

10.2.3. Joseph Stine

10.2.3.1. In his report, Stine asserts that GSR had come into question well prior to this incident, and he opined that it was im-

properly relied upon in the investigation into Michelle Dyson's death.

- Stine asserts that, as "early as 1970," while he was servicing as Philadelphia homicide detective, "the efficacy of GSR testing was coming into question. The rapid deterioration of the residue and the ease of transfer were recognized problems. Because of these problems GSR was not considered to be a determining factor when charging persons with the discharge of firearms during criminal activity" (Stine Report, p. 19). Stine did not cite any empirical, textbook, or training literature to support his opinion.

- According to Stine, the Philadelphia Police Department stopped using GSR testing by 1980. However, a quick Internet search turned up two court cases—one from a 1997 civil case in U. S. District Court and one from a 2012 criminal case in Pennsylvania Superior Court—that refer to gunshot primer residues being used in Philadelphia cases.[2]

- While Stine's experiences may provide anecdotal evidence of what was taking place within the Philadelphia Police Department and Stine's circle of experience, neither the empirical nor the textbook literature prevalent

[2] In *Commonwealth of Pennsylvania v. Tyree Musier* (Superior Court of Pennsylvania, No. 2575 EDA 2012, J.S26038/14), the Court mentioned that "[f]orensic tests on [a] green shirt disclosed primer gunshot residue" (p. 3, retrieved from https://cases.justia.com/pennsylvania/superior-court/2014-2575-eda-2012.pdf?ts=1408044807). In *Estate of Kenneth Griffin v. Isaac Hickson, et al.* (Civil Action No. 98-3805), the United States District Court for the Eastern District of Pennsylvania ruled on a motion regarding the admissibility of GSR evidence found on the hand of a person who was shot and killed by Pennsylvania state agents in Philadelphia (retrieved from https://www.paed.uscourts.gov/documents/opinions/02D0361P.pdf).

when this incident took place supports Stine's conclusion that Van Gelder and the investigators in this case should have been aware that transfer of GSR was the likely explanation for the positive GSR test results on the samples collected from Burgess.

10.2.3.2. Stine opined that the "reliance on and use . . . of GSR evidence and testimony to obtain the conviction of Sabein Burgess for the murder of Michelle Dyson was contrary to generally accepted practices and procedures for professional law enforcement agencies in 1994" (Stine Report, p. 19). He also opined that it "was widely known by police professionals that GSR could be deposited on someone who had *not* fired a gun or been present when one was fired, but who walked through a cloud of gun smoke and who cradled the body of someone shot at close range" (p. 27, emphasis in original). Stine has provided no scientific evidence to support this opinion, which is contrary to the prevailing empirical, textbook, and training literature available in 1995.

10.2.3.3. Stine did not cite any literature or provide any scientific evidence that the probability of transfer from the victim to Burgess's hands in the quantities that were detected in the samples was inconsistent with Van Gelder's testimony in this case that the probability of transfer was "very small."

10.2.3.4. The only support that Stine offered for his opinions are his experiences working at the Philadelphia Police Department, discussions that occurred during a class at the FBI National

Academy, and experiences serving on the education and training committee of the International Association of Chiefs of Police. Stine did not provide any evidence that his experiences should have been known by Van Gelder or any of the investigators in this case.

10.2.3.5. Stine did not expressly opine that Van Gelder had fabricated the GSR findings, his report, or his trial testimony, he did state: "It is my opinion that the members of the BPD who used GSR evidence to convict Mr. Burgess of the Homicide of Michelle Dyson, knew that this type of evidence was unreliable and deliberately tailored its use and the testimony about it to improperly influence the jury" (Stine Report, p. 20). Stine offered no support, scientific or otherwise, for his conclusion. It is a huge leap to go from opining that Van Gelder gave inaccurate testimony to opining that he "deliberately tailored" his testimony to ensure Burgess's conviction. Absent any supporting evidence, it is difficult to envision how Stine's opinion is anything but conclusory.

10.3. Appropriateness of Van Gelder's Report & Testimony

10.3.1. Van Gelder's laboratory report, which was templated requiring Van Gelder only to check or circle particular reporting choices, stated: "Gunshot primer residues were found on the hand(s) of the subject. There is a possibility that these residues were transferred from the surface of a firearm or from an object which lay immediately adjacent to a firearm during its discharge. Most probably, however, the subject's hands were immediately adjacent to a discharging firearm or were

themselves used to fire the firearm within a few hours of" when the samples were collected (Individual Defendants 006910).

10.3.1.1. This reporting language acknowledges that GSR transfer was possible.

10.3.1.2. This reporting language was not inconsistent with the prevailing empirical, textbook, and training literature available in 1994.

10.3.2. Van Gelder testified at trial that there was "a very small possibility" that the particles had been transferred to Burgess's hands (Van Gelder Deposition, pp. 231-232; Criminal Trial Transcript, pp. 220-221). Plaintiff's experts have not cited any scientific literature to dispute that statement. The mere fact that transfer *can* happen does not provide any assessment as to *the probability that it will*, especially in the numbers of particles characteristic of, and consistent with, GSR found on Burgess's hands.

10.3.3. In his Petition for Writ of Actual Innocence, Burgess specifically argued that Van Gelder *would not have been aware* of advances in GSR technology that might have impacted his opinion. "While Burgess's counsel attempted to raise the issue of transfer at Burgess's trial," Burgess argued, "the state of the science at the time did not support this theory" (p. 23). Burgess argued that changes in the scientific understanding of the probative value of GSR results did not arise until after the May 1997 deadline for Burgess to file a motion for a new trial.

10.3.3.1. Contrary to Burgess's argument in his Petition for Writ of Actual Innocence, in the Complaint in this case, Burgess alleges that Van Gelder purposely fabricated GSR evidence.

10.3.4. Even today, both the empirical and textbook literature paint a picture of GSR interpretation being a subjective matter that requires an examiner to employ his or her judgment on a case-specific basis. To this day, there remain no reliable diagnostic tools that can provide any quantitative analysis as to the probability of transfer from a victim to a subject's hands.

10.3.5. The paucity of empirical research on the topic of GSR transfer and its potential role in false positive GSR test conclusions stands as an indicator of the relative infrequency with which such transfers occur in casework. While numerous studies have been carried out with respect to the reliability of sampling and testing methods for detecting GSR and preventing false negatives, almost no research has been done with respect to assessing or preventing false positives with respect to the significance of a finding that GSR was present on a subject's hands.

10.3.6. It stands to reason that, if the probability of false positive results due to GSR transfer was widely understood in 1994, the textbook literature on the topic would contain abundant references to such problems. Instead, there are virtually none. While transfer was acknowledged to occur, not one single textbook in my library devotes more than a passing reference to the possibility, and none of the textbooks provides any discussion as to the probability of a false positive due to transfer vis-à-vis the probability of a correct positive conclusion due to the presence of GSR particles. In fact, where references to GSR transfer are present

in the textbook literature to date, they are overwhelmingly focused on transfer due to handling a firearm or ammunition.

10.3.7. In the absence of empirical, textbook, or training literature that would have provided Van Gelder with a quantitative basis for expressing the probability that the GSR particles found on Burgess's hands were due to transfer, Van Gelder turned to the empirical evidence he had at hand: his experience conducting analyses in the laboratory. Van Gelder based his conclusion on the number of particles found on the two stubs vis-à-vis the numbers of particles typically found on samples of subjects in the laboratory who have fired a gun, which is a reasonable scientific basis for his conclusion.

10.3.8. Viewing this case more than two decades later, with the benefit of the collective experience and literature that has been gained during that intervening period, can lead to a skewed interpretation of the propriety of Van Gelder's conclusions and testimony in 1994 and 1995. Very few scientific conclusions are beyond criticism, and almost no scientific field has remained unchanged by advances in technology and the publication of new research over a two-decade timespan. Indeed, during my search for empirical literature related to GSR evidence, I found significantly more literature that has been published in the two decades since Burgess's arrest and conviction than I found from the two decades prior.

10.3.9. During his testimony, Van Gelder acknowledged that GSR transfer was possible; the issue in question is whether or not it was appropriate for him to characterize that possibility as "unlikely." The state of the empirical, textbook, and training literature available at that time does not conflict with that testimony. Still to this day, the literature establishes

only that (1) transfers of GSR from a surface contaminated with GSR to a subject's hands are possible, and (2) the probability of transfer is something less than the probability of GSR being found due to the subject being present when a firearm was discharged, though how much less is unclear.

10.3.10. By today's standards, without having ruled out transfer as a possible explanation for the presence of GSR on a subject's hands, testimony would likely be presented in a manner that would not suggest that any one possibility is more likely than any other possibility. Still, that testimony, while abundantly careful, is not accurate and is potentially misleading; it is used to craft testimony that reduces the possibility that a trier of fact will give undue weight to GSR evidence. But this was not the standard in 1995 when Van Gelder testified in Burgess's criminal trial.

10.3.10.1. None of the Plaintiff's experts in this case have cited any literature to establish that today's standard for GSR testimony was the standard in 1995, and some of the literature they cited contradicts the conclusion that it was.[3]

10.3.10.2. Kilty did not expressly opine that Van Gelder should have known that, in 1995, his conclusions and testimony were scientifically unsupported. Instead, Burgess, relying on Kilty's report, argued that the changes in changes in GSR protocols now in place were not in place at the time of Burgess's criminal trial.

[3] See, for example, Aaron (1991), which was cited by Niemeyer. Aaron limited the appropriate testimony to the conclusion that the subject had either fired a gun, been present when a gun was fired, or touched ammunition or a gun after it had been fired.

10.3.10.3. Both Niemeyer and Stine have opined that, based on their experiences, they believe the Van Gelder should have known that his testimony in 1995 was inappropriate, but neither expert has cited any literature to support their opinions, nor have they demonstrated that their experiences were similar to Van Gelder's. To that extent, their opinions are without scientific support.

10.3.11. In his Complaint in this case, Burgess alleges that Van Gelder fabricated the GSR evidence used against him at trial. However, none of the expert reports tendered by Burgess in this case have provided even one single piece of evidence to support that contention, and none of the experts have concluded that Van Gelder did, in fact, fabricate his findings, report, or testimony.

10.3.11.1. Burgess himself argued in his Petition for Writ of Actual Innocence that Van Gelder's testimony in 1995 could not be challenged by defense counsel because the state of the science allowing such challenges did not come about until several years after Burgess was convicted.

11. Conclusions

11.1. Based on my review of this case, and in light of my training, education, and experience in crime scene reconstruction, I can offer the following opinions to a reasonable degree of scientific certainty in this case for the reasons previously laid out in this report.

11.2. There exists no support for the contention that Van Gelder fabricated his findings, report, or testimony in this case.

11.3. The evidence in this case, despite a somewhat ambiguous physical gesturing and description in the trial transcript of Meinhardt's testimony, does not allow for a determination that the palms were included in the sampling process as being more probable than the sampling being done only on the back of the hand as per the GSR collection form instructions. Moreover, even if the palms were sampled, the evidence in this case does not support the contention that Van Gelder knew or should have known that sampling was done on the palms prior to drafting his report or and testifying at trial.

11.4. The empirical literature on the topic of gunshot primer residue in criminal cases does not paint the picture of GSR transference being equally probable to GSR being present from discharging a firearm or being present when a firearm was discharged.

11.4.1. If GSR transfer was known, understood, and viewed as anything greater than "unlikely" when Van Gelder testified in 1995, it stands to reason that the issue would have been significantly represented in the empirical, textbook, and training literature. Instead, it was barely mentioned.

11.4.2. Even today, there exists scant empirical research regarding GSR transfer from one person to another person, such as might occur when a person touches a shooting victim, which means that the issue, while acknowledged by practitioners, is still not significant enough to justify empirical research.

11.5. There does not exist scientific support for the conclusion that Van Gelder's report or subsequent testimony in this case was unreasonable with regard to the probability of GSR transfer being "very small" in light of the prevailing state of the science in 1995.

11.5.1. While GSR transfers from contact can occur, there is a paucity of empirical research to establish the probability of such transference.

11.5.2. To say that GSR transfers can occur due to contact is mathematically defined as $p_{transfer} > 0$.

11.5.3. The combined probability of the three commonly-accepted possibilities for GSR being present on a subject's hands can be mathematically expressed as $p_{fired} + p_{present} + p_{transfer} = 1.0$. The individual probabilities are not defined in the empirical literature, but the literature does certainly imply that $p_{fired} + p_{present} >> p_{transfer}$.

11.5.4. If $p_{fired} = p_{present} = p_{transfer}$, it is true that $p_{fired} + p_{present} > p_{transfer}$ because $p_{fired} + p_{present} = 2(p_{transfer})$. Therefore, the probability of transfer cannot exceed 33%.

11.5.5. The empirical literature does not support the contention that the probability of transfer was equal to or greater than the probability of a correct positive finding that Burgess was present when at least one shot was fired given the facts know by Van Gelder at the time of his analysis and testimony in this case.

11.6. The Plaintiff's experts in this case have not provided scientific support for the conclusion that Van Gelder's 1994 report and 1995 testimony were inappropriate under the circumstances of the case and the state of the science as he knew them at that time.

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Knox & Associates, LLC, reserves the right to amend or otherwise change the conclusions contained herein if new information becomes available that was not known to Knox & Associates, LLC, at the time this report was prepared.

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Certification of Truth and Accuracy

I, the undersigned, Michael A. Knox, as a qualified forensic consultant, do hereby certify this report and attest to its truth and accuracy to the best of my knowledge and ability. The conclusions made herein are my own, have been formed objectively, and have not been made under duress or promise of pecuniary benefit. The analysis and conclusions contained herein have been formed based on my training, education, and experience relevant to the forensic reconstruction of firearms incidents to a reasonable degree of scientific certainty.

Michael A. Knox
Board Certified Crime Scene Reconstructionist

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